psychological and psychosocial disorders appears unrelated to TCDD body burdens in Ranch Hands.

## SUMMARY

The psychological assessment was based on analyses of verified psychological disorders; reported sleep disorders; and two psychological instruments, the SCL-90-R and the MCMI, in association with serum dioxin levels. Tables 9-55, 9-56, and 9-57 present the results of these analyses based on initial dioxin for Ranch Hands, current dioxin and time since tour for Ranch Hands, and current dioxin category for Ranch Hands and Comparisons.

### Questionnaire: Verified

Five psychological disorders were analyzed in the psychological assessment: psychoses, alcohol dependence, drug dependence, anxiety, and other neuroses. These disorders were self-reported and later verified by a medical record review. Participants with a pre-SEA history of these disorders were excluded from the analyses along with participants with PTSD as determined from the MMPI.

#### *Model 1: Ranch Hands - $Log_2$ (Initial Dioxin)*

In the unadjusted analysis of psychoses, a marginally significant negative association was found with initial dioxin under the minimal assumption. After adjustment for race and education, the negative association between psychoses and initial dioxin became significant (Table 9-55: p=0.042) for the minimal cohort.

There were no significant findings in the analysis of alcohol dependence, and there were only two participants (both Comparisons) with a verified self-reported history of a drug dependence.

In the unadjusted analyses of anxiety and the ICD-9-CM code-based category of "other neuroses," the minimal analyses were nonsignificant, but the maximal analyses detected a significant positive association with initial dioxin for both of these psychological disorders (Table 9-55: p=0.34 and p=0.004). The adjusted analyses of anxiety and other neuroses displayed nonsignificant positive associations with initial dioxin under both assumptions.

#### *Model 2: Ranch Hands - $Log_2$ (Current Dioxin) and Time*

The association between current dioxin and the verified psychological disorder variables did not differ significantly between the time since tour strata for any of the unadjusted analyses. However, for other neuroses, the unadjusted maximal analysis detected a marginally significant current dioxin-by-time interaction. Also, under the maximal assumption, there was a significant positive association between current dioxin and anxiety and between current dioxin and other neuroses in the unadjusted analysis of Ranch Hands with less than or equal to 18.6 years since tour (Table 9-56: p=0.034 and p=0.003, respectively).

## TABLE 9-55.

**Summary of Initial Dioxin Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)**

| | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| Variable | Minimal | Maximal | Minimal | Maximal |
| **Questionnaire: Verified** | | | | |
| Psychoses (D) | ns* | NS | -0.042 | ns |
| Alcohol Dependence (D) | NS | NS | ns | NS |
| Anxiety (D) | NS | +0.034 | NS | NS |
| Other Neuroses (D) | NS | +0.004 | NS | NS |
| **Questionnaire: Sleep Disorders** | | | | |
| Trouble Falling Asleep (D) | ns | NS | ns* | ns |
| Waking Up During the Night (D) | ns | ns | ns | ns |
| Waking Up Too Early and Can't Go Back to Sleep (D) | ns | NS | ** (ns) | ns |
| Waking Up Unrefreshed (D) | NS | +0.027 | NS | NS |
| Involuntarily Falling Asleep During the Day (D) | ns | NS | ** (ns) | ** (NS) |
| Great or Disabling Fatigue During the Day (D) | ns | NS | ns | ns |
| Frightening Dreams (D) | NS | +0.025 | ** (NS) | NS* |
| Talking in Sleep (D) | NS | NS | NS | NS |
| Sleepwalking (D) | NS | NS | **** | NS |
| Abnormal Movement/ Activity During the Night (D) | NS | NS | ns | NS |
| Sleep Problems Requiring Medication (D) | ns | ns | -0.023 | -0.032 |
| Snore Loudly in All Sleeping Positions (D) | ns | NS | ** (ns) | NS |

**TABLE 9-55. (Continued)**

**Summary of Initial Dioxin Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)**

| | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| Variable | Minimal | Maximal | Minimal | Maximal |
| **Questionnaire: Sleep Disorders (continued)** | | | | |
| Insomnia (D) | ns | ns | ns | ns |
| Overall Sleep Disorder Index (D) | ns | NS | ns | ns |
| Average Sleep Each Night[a](C) | ns | ns | ns | ns |
| **Physical Examination: SCL-90-R** | | | | |
| Anxiety (D) | NS | +0.022 | NS | NS |
| Depression (D) | NS* | +0.029 | NS | NS |
| Hostility (D) | NS | NS | ns | NS |
| Interpersonal Sensitivity (D) | NS | NS* | ** (NS) | NS |
| Obsessive-Compulsive Behavior (D) | NS* | +0.002 | NS | NS* |
| Paranoid Ideation (D) | ns | ns | ns | ns |
| Phobic Anxiety (D) | NS | NS | ns | NS |
| Psychoticism (D) | NS | +0.022 | NS | NS* |
| Somatization (D) | NS | NS* | NS | NS |
| Global Severity Index (D) | NS* | +0.013 | NS | NS |
| Positive Symptom Total (D) | NS* | +0.043 | NS | NS |
| Positive Symptom Distress Index (D) | NS | NS | NS | NS |
| **Physical Examination: MCMI** | | | | |
| Basic Personality Patterns | | | | |
| Schizoid Score (C) | +<0.001 | +<0.001 | +0.002 | +0.002 |
| Avoidant Score (C) | +<0.001 | +<0.001 | ** (+0.003) | +0.038 |
| Dependent Score (C) | +0.027 | +0.009 | +0.018 | +0.037 |
| Histrionic Score (C) | -0.003 | -0.002 | -0.011 | -0.037 |
| Narcissistic Score (C) | -0.007 | -0.003 | ns* | -0.012 |
| Antisocial Score (C) | ns | ns | ** (ns) | **** |
| Compulsive Score (C) | ns | ns | NS | NS |

## TABLE 9-55. (Continued)

### Summary of Initial Dioxin Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)

| Variable | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | Minimal | Maximal | Minimal | Maximal |
| **Physical Examination: MCMI (continued)** | | | | |
| Basic Personality Patterns (continued) | | | | |
| Passive-Aggressive Score (C) | +0.046 | +<0.001 | NS | NS |
| Pathological Personality Disorders | | | | |
| Schizotypal Score (C) | +<0.001 | +<0.001 | +<0.001 | +0.001 |
| Borderline Score (C) | NS | +0.028 | NS | ** (NS) |
| Paranoid Score (C) | NS | NS | NS | ns |
| Clinical Symptom Syndromes | | | | |
| Anxiety Score (C) | +0.046 | +<0.001 | ** (NS*) | **** |
| Somatoform Score (C) | NS | +0.033 | NS | +0.011 |
| Hypomania Score (C) | ns* | ns | ** (ns*) | ** (ns) |
| Dysthymia Score (C) | NS | +0.031 | **** | **** |
| Alcohol Abuse Score (C) | NS | NS | ns | ns |
| Drug Abuse Score (C) | ns | NS | ns | ns |
| Psychotic Thinking Score (C) | +<0.001 | +<0.001 | +0.001 | +0.021 |
| Psychotic Depression Score (C) | +0.005 | +<0.001 | +0.035 | NS* |
| Psychotic Delusion Score (C) | NS | NS* | NS | NS |

[a]Negative slope considered adverse for this variable.
C: Continuous analysis.
D: Discrete analysis.
+: Relative risk 1.00 or greater for discrete analysis; slope nonnegative for continuous analysis.
-: Relative risk less than 1.00 for discrete analysis; slope negative for continuous analysis.
NS/ns: Not significant ($p>0.10$).
NS*/ns*: Marginally significant ($0.05<p\leq0.10$).
** (NS)/** (ns): $Log_2$ (initial dioxin)-by-covariate interaction ($0.01<p\leq0.05$); not significant when interaction is deleted; refer to Appendix Table H-1 for a detailed description of this interaction.
** (NS*)/** (ns*): $Log_2$ (initial dioxin)-by-covariate interaction ($0.01<p\leq0.05$); marginally significant when interaction is deleted; refer to Appendix Table H-1 for a detailed description of this interaction.
** (...): $Log_2$ (initial dioxin)-by-covariate interaction ($0.01<p\leq0.05$); significant when interaction is deleted and p-value is given in parentheses; refer to Appendix Table H-1 for a detailed description of this interaction.
****: $Log_2$ (initial dioxin)-by-covariate interaction ($p\leq0.01$); refer to Appendix Table H-1 for a detailed description of this interaction.
Note: P-value given if $p\leq0.05$.
A capital "NS" denotes relative risk 1.00 or greater for discrete analysis or slope nonnegative for continuous analysis; a lowercase "ns" denotes relative risk less than 1.00 for discrete analysis or slope negative for continuous analysis.

## TABLE 9-56.

**Summary of Current Dioxin and Time Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)**

| | Unadjusted | | | | | |
|---|---|---|---|---|---|---|
| | Minimal | | | Maximal | | |
| Variable | C*T | ≤18.6 | >18.6 | C*T | ≤18.6 | >18.6 |
| **Questionnaire: Verified** | | | | | | |
| Psychoses (D) | ns | ns | ns | ns | NS | ns |
| Alcohol Dependence (D) | ns | NS | ns | ns | NS | ns |
| Anxiety (D) | NS | NS | NS | ns | +0.034 | NS |
| Other Neuroses (D) | ns | NS | NS | ns* | +0.003 | NS |
| **Questionnaire: Sleep Disorders** | | | | | | |
| Trouble Falling Asleep (D) | NS | ns | NS | ns | NS | ns |
| Waking Up During the Night (D) | ns | ns | ns | ns | NS | ns |
| Waking Up Too Early and Can't Go Back to Sleep (D) | ns | NS | ns | ns | NS | ns |
| Waking Up Unrefreshed (D) | NS | ns | NS | NS | NS | +0.030 |
| Involuntarily Falling Asleep During the Day (D) | ns | NS | ns | ns* | NS | ns |
| Great or Disabling Fatigue During the Day (D) | NS | ns | ns | ns | NS | ns |
| Frightening Dreams (D) | ns | NS | NS | ns | +0.011 | NS |
| Talking in Sleep (D) | ns | NS | NS | ns | NS | NS |
| Sleepwalking (D) | NS | ns | NS | NS | NS | NS |
| Abnormal Movement/ Activity During the Night (D) | ns | NS | NS | NS | NS | NS |
| Sleep Problems Requiring Medication (D) | NS | ns | ns | ns | ns | ns |
| Snore Loudly in All Sleeping Positions (D) | ns | ns | ns | ns | NS | NS |
| Insomnia (D) | ns | NS | ns | ns* | NS | ns |
| Overall Sleep Disorder Index (D) | ns | NS | ns | ns | NS | ns |
| Average Sleep Each Night[a](C) | ns | ns | ns | NS | ns | ns |

**TABLE 9-56. (Continued)**

**Summary of Current Dioxin and Time Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)**

| | Unadjusted | | | | | |
|---|---|---|---|---|---|---|
| | Minimal | | | Maximal | | |
| Variable | C*T | ≤18.6 | >18.6 | C*T | ≤18.6 | >18.6 |
| **Physical Examination: SCL-90-R** | | | | | | |
| Anxiety (D) | NS | NS | +0.031 | NS | NS | NS* |
| Depression (D) | NS | NS | +0.017 | ns | NS | NS* |
| Hostility (D) | ns | NS | NS | ns | NS | NS |
| Interpersonal Sensitivity (D) | ns | NS* | NS | ns | +0.018 | NS |
| Obsessive-Compulsive Behavior (D) | NS | NS | +0.031 | NS | +0.043 | +0.018 |
| Paranoid Ideation (D) | ns | ns | ns | ns | NS | ns |
| Phobic Anxiety (D) | NS | ns | NS | ns | NS | NS |
| Psychoticism (D) | NS | NS | NS | ns | NS | NS |
| Somatization (D) | +0.015 | ns | NS* | NS | NS | NS |
| Global Severity Index (D) | NS | NS | +0.026 | ns | NS* | NS* |
| Positive Symptom Total (D) | NS | NS | NS | ns | +0.041 | NS |
| Positive Symptom Distress Index (D) | NS | ns | NS | ns | NS | NS |
| **Physical Examination: MCMI** | | | | | | |
| Basic Personality Patterns | | | | | | |
| Schizoid Score (C) | NS* | NS | +<0.001 | NS* | NS | +<0.001 |
| Avoidant Score (C) | +0.028 | NS | +<0.001 | NS* | NS | +<0.001 |
| Dependent Score (C) | NS | NS | +0.033 | NS | NS | +0.023 |
| Histrionic Score (C) | ns* | ns | -0.001 | ns* | ns | -<0.001 |
| Narcissistic Score (C) | ns | ns | -0.015 | ns | ns | -0.005 |
| Antisocial Score (C) | ns | NS | ns | ns | NS | ns |
| Compulsive Score (C) | ns | ns | ns | ns | ns | ns |
| Passive-Aggressive Score (C) | NS | NS | +0.037 | NS | +0.044 | +0.007 |

## TABLE 9-56. (Continued)

### Summary of Current Dioxin and Time Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)

| | Unadjusted | | | | | |
|---|---|---|---|---|---|---|
| | Minimal | | | Maximal | | |
| Variable | C*T | ≤18.6 | >18.6 | C*T | ≤18.6 | >18.6 |
| **Physical Examination: MCMI (continued)** | | | | | | |
| Pathological Personality Disorders | | | | | | |
| Schizotypal Score (C) | NS | NS | +<0.001 | NS | +0.037 | +<0.001 |
| Borderline Score (C) | NS | ns | NS | NS | NS | NS* |
| Paranoid Score (C) | NS | NS | NS | ns | NS | NS |
| Clinical Symptom Syndromes | | | | | | |
| Anxiety Score (C) | NS | ns | +0.026 | ns | +0.038 | +0.028 |
| Somatoform Score (C) | NS | NS | NS | ns | NS* | NS |
| Hypomania Score (C) | ns | ns | ns* | ns | ns | -0.050 |
| Dysthymia Score (C) | NS | NS | NS | NS | NS | NS* |
| Alcohol Abuse Score (C) | NS | ns | NS | NS | ns | NS |
| Drug Abuse Score (C) | ns | NS | ns | ns | NS | ns |
| Psychotic Thinking Score (C) | NS* | NS | +<0.001 | NS* | NS | +<0.001 |
| Psychotic Depression Score (C) | NS | NS | +0.006 | NS | NS | +<0.001 |
| Psychotic Delusion Score (C) | NS | NS | +0.041 | NS | NS | +0.020 |

[a]Negative slope considered adverse for this variable.
C: Continuous analysis.
D: Discrete analysis.
+: C*T: Relative risk/slope for ≤18.6 category less than relative risk/slope for >18.6 category.
≤18.6 and >18.6: Relative risk 1.00 or greater for discrete analysis; slope nonnegative for continuous analysis.
-: C*T: Relative risk/slope for ≤18.6 category greater than relative risk/slope for >18.6 category.
≤18.6 and >18.6: Relative risk less than 1.00 for discrete analysis; slope negative for continuous analysis.
NS/ns: Not significant (p>0.10).
NS*/ns*: Marginally significant (0.05<p≤0.10).
Note: P-value given if p≤0.05.
C*T: $Log_2$ (current dioxin)-by-time interaction hypothesis test.
≤18.6: $Log_2$ (current dioxin) hypothesis test for Ranch Hands with time since end of tour of 18.6 years or less.
>18.6: $Log_2$ (current dioxin) hypothesis test for Ranch Hands with time since end of tour greater than 18.6 years.
A capital "NS" denotes relative risk/slope for ≤18.6 category less than relative risk/slope for >18.6 category, relative risk 1.00 or greater for discrete analysis, or slope nonnegative for continuous analysis; a lowercase "ns" denotes relative risk/slope for ≤18.6 category greater than relative risk/slope for >18.6 category, relative risk less than 1.00 for discrete analysis, or slope negative for continuous analysis.

## TABLE 9-56. (Continued)

### Summary of Current Dioxin and Time Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)

| | Adjusted | | | | | |
|---|---|---|---|---|---|---|
| | Minimal | | | Maximal | | |
| Variable | C*T | ≤18.6 | >18.6 | C*T | ≤18.6 | >18.6 |
| **Questionnaire: Verified** | | | | | | |
| Psychoses (D) | ns | ns | ns | ns | NS | ns |
| Alcohol Dependence (D) | ns | NS | ns | ns | NS | ns |
| Anxiety (D) | NS | NS | NS | ns | NS | NS |
| Other Neuroses (D) | ns | NS | ns | ns | NS* | ns |
| **Questionnaire: Sleep Disorders** | | | | | | |
| Trouble Falling Asleep (D) | NS | ns | ns | ns | ns | ns |
| Waking Up During the Night (D) | **** | **** | **** | **** | **** | **** |
| Waking Up Too Early and Can't Go Back to Sleep (D) | ns | NS | ns | ns | NS | ns |
| Waking Up Unrefreshed (D) | ** (NS) | ** (ns) | ** (NS) | NS | ns | NS |
| Involuntarily Falling Asleep During the Day (D) | ns | NS | ns | ns* | NS | ns |
| Great or Disabling Fatigue During the Day (D) | **** | **** | **** | ns | NS | ns |
| Frightening Dreams (D) | **** | **** | **** | ** (ns) | ** (+0.033) | ** (NS) |
| Talking in Sleep (D) | ns | NS | NS | ns | NS | NS |
| Sleepwalking (D) | NS | ns | NS | NS | NS | NS |
| Abnormal Movement/ Activity During the Night (D) | ns | NS | ns | NS | NS | NS |
| Sleep Problems Requiring Medication (D) | NS | ns* | ns* | NS | ns | ns* |
| Snore Loudly in All Sleeping Positions (D) | ns | ns | ns | ns | NS | NS |
| Insomnia (D) | ns | NS | ns | ns* | NS | ns* |
| Overall Sleep Disorder Index (D) | ns | ns | ns* | ns | NS | ns |
| Average Sleep Each Night[a] (C) | **** | **** | **** | ** (NS) | ** (ns) | ** (ns) |

**TABLE 9-56. (Continued)**

**Summary of Current Dioxin and Time Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)**

| | Adjusted | | | | | |
|---|---|---|---|---|---|---|
| | Minimal | | | Maximal | | |
| Variable | C*T | ≤18.6 | >18.6 | C*T | ≤18.6 | >18.6 |
| **Physical Examination: SCL-90-R** | | | | | | |
| Anxiety (D) | NS* | ns | +0.028 | NS | NS | NS |
| Depression (D) | NS | ns | NS | ns | NS | NS |
| Hostility (D) | NS | ns | ns | ns | NS | ns |
| Interpersonal Sensitivity (D) | ns | NS | NS | ns | NS* | NS |
| Obsessive-Compulsive Behavior (D) | NS | ns | NS | ns | NS | NS |
| Paranoid Ideation (D) | ns | ns | ns | ns | NS | ns |
| Phobic Anxiety (D) | ** (NS) | ** (ns) | ** (NS) | ** (ns) | ** (NS) | ** (NS) |
| Psychoticism (D) | NS | NS | NS | ns | NS | NS |
| Somatization (D) | +0.025 | ns | NS* | ** (NS) | ** (NS) | ** (NS) |
| Global Severity Index (D) | ** (NS) | ** (NS) | ** (NS) | ns | NS | NS |
| Positive Symptom Total (D) | NS | NS | NS | ns | NS | NS |
| Positive Symptom Distress Index (D) | NS | ns | NS | ns | NS | NS |
| **Physical Examination: MCMI** | | | | | | |
| Basic Personality Patterns | | | | | | |
| Schizoid Score (C) | NS* | NS | +0.001 | ** (+0.044) | ** (NS) | ** (+<0.001) |
| Avoidant Score (C) | +0.029 | NS | +<0.001 | +0.045 | ns | +0.006 |
| Dependent Score (C) | NS | NS | +0.020 | NS | NS | +0.026 |
| Histrionic Score (C) | ns | ns | -0.006 | **** | **** | **** |
| Narcissistic Score (C) | ns | NS | ns* | ns* | ns | -0.009 |
| Antisocial Score (C) | ns | NS | ns | ns | NS | ns |
| Compulsive Score (C) | ns | NS | NS | ns | NS | NS |
| Passive-Aggressive Score (C) | NS | ns | NS | NS | NS | NS |
| Pathological Personality Disorders | | | | | | |
| Schizotypal Score (C) | NS | NS | + 0.002 | NS | NS | +0.002 |
| Borderline Score (C) | NS | ns | NS | NS | NS | NS |
| Paranoid Score (C) | NS | NS | NS | ns | NS | NS |

## TABLE 9-56. (Continued)

### Summary of Current Dioxin and Time Analyses for Psychology Variables Based on Minimal and Maximal Assumptions (Ranch Hands Only)

| | Adjusted | | | | | |
|---|---|---|---|---|---|---|
| | Minimal | | | Maximal | | |
| Variable | C*T | ≤18.6 | >18.6 | C*T | ≤18.6 | >18.6 |
| **Physical Examination: MCMI (continued)** | | | | | | |
| Clinical Symptom Syndromes | | | | | | |
| Anxiety Score (C) | NS | ns | NS* | ns | NS | NS |
| Somatoform Score (C) | NS | NS | NS | ns | +0.030 | NS |
| Hypomania Score (C) | ns | ns | ns* | ns | NS | -0.045 |
| Dysthymia Score (C) | NS | NS | NS | NS | NS | NS* |
| Alcohol Abuse Score (C) | NS | ns | NS | NS | ns | ns |
| Drug Abuse Score (C) | ns | NS | ns | ns | NS | ns |
| Psychotic Thinking Score (C) | NS* | NS | +<0.001 | NS* | NS | +0.001 |
| Psychotic Depression Score (C) | NS | NS | +0.034 | NS | NS | +0.017 |
| Psychotic Delusion Score (C) | NS | ns | NS | NS | ns | NS* |

[a]Negative slope considered adverse for this variable.
C: Continuous analysis.
D: Discrete analysis.
+: C*T: Relative risk/slope for ≤18.6 category less than relative risk/slope for >18.6 category.
≤18.6 and >18.6: Relative risk 1.00 or greater for discrete analysis; slope nonnegative for continuous analysis.
-: C*T: Relative risk/slope for ≤18.6 category greater than relative risk/slope for >18.6 category.
≤18.6 and >18.6: Relative risk less than 1.00 for discrete analysis; slope negative for continuous analysis.
NS/ns: Not significant (p>0.10).
NS*/ns*: Marginally significant (0.05<p≤0.10).
** (NS)/** (ns): $Log_2$ (current dioxin)-by-time-by-covariate interaction (0.01<p≤0.05); not significant when interaction is deleted; refer to Appendix Table H-1 for a detailed description of this interaction.
** (...): Categorized current dioxin-by-covariate interaction (0.01<p≤0.05); significant when interaction is deleted and p-value is given in parentheses; refer to Appendix Table H-1 for a detailed description of this interaction.
****: $Log_2$ (current dioxin)-by-time-by-covariate interaction (p≤0.01); refer to Appendix Table H-1 for a detailed description of this interaction.
Note: P-value given if p≤0.05.
C*T: $Log_2$ (current dioxin)-by-time interaction hypothesis test.
≤18.6: $Log_2$ (current dioxin) hypothesis test for Ranch Hands with time since end of tour of 18.6 years or less.
>18.6 $Log_2$ (current dioxin) hypothesis test for Ranch Hands with time since end of tour greater than 18.6 years.
A capital "NS" denotes relative risk/slope for ≤18.6 category less than relative risk/slope for >18.6 category, relative risk 1.00 or greater for discrete analysis, or slope nonnegative for continuous analysis; a lowercase "ns" denotes relative risk/slope for ≤18.6 category greater than relative risk/slope for >18.6 category, relative risk less than 1.00 for discrete analysis, or slope negative for continuous analysis.

## TABLE 9-57.

**Summary of Categorized Current Dioxin Analyses for Psychology Variables (Ranch Hands and Comparisons)**

| | Unadjusted | | | |
|---|---|---|---|---|
| Variable | All | Unknown versus Background | Low versus Background | High versus Background |
| **Questionnaire: Verified** | | | | |
| Psychoses (D) | NS | ns | ns | ns |
| Alcohol Dependence (D) | NS | NS | ns | NS |
| Anxiety (D) | NS | ns | NS | NS |
| Other Neuroses (D) | 0.008 | ns | +0.003 | NS |
| **Questionnaire: Sleep Disorders** | | | | |
| Trouble Falling Asleep (D) | NS | ns | ns* | ns |
| Waking Up During the Night (D) | NS | ns | ns | ns |
| Waking Up Too Early and Can't Go Back to Sleep (D) | NS | ns | ns | ns |
| Waking Up Unrefreshed (D) | NS* | ns* | ns | NS |
| Involuntarily Falling Asleep During the Day (D) | NS | NS | ns | NS |
| Great or Disabling Fatigue During the Day (D) | NS | ns | NS | NS |
| Frightening Dreams (D) | 0.010 | ns | ns | +0.002 |
| Talking in Sleep (D) | NS | ns | ns | +0.038 |
| Sleepwalking (D) | NS | NS | ns | NS |
| Abnormal Movement/ Activity During the Night (D) | NS | ns | NS | ns |
| Sleep Problems Requiring Medication (D) | NS | NS | NS | ns |
| Snore Loudly in All Sleeping Positions (D) | NS | ns | NS | NS |
| Insomnia (D) | NS | ns | ns | ns |
| Overall Sleep Disorder Index (D) | NS | ns | NS | NS |
| Average Sleep Each Night[a] (C) | NS | NS | NS | ns |

**TABLE 9-57. (Continued)**

**Summary of Categorized Current Dioxin Analyses for Psychology Variables (Ranch Hands and Comparisons)**

| | | Unadjusted | | |
|---|---|---|---|---|
| Variable | All | Unknown versus Background | Low versus Background | High versus Background |
| **Physical Examination: SCL-90-R** | | | | |
| Anxiety (D) | 0.043 | ns | NS | +0.012 |
| Depression (D) | NS* | ns | NS | +0.015 |
| Hostility (D) | NS | ns | NS | NS |
| Interpersonal Sensitivity (D) | NS | ns | ns | NS |
| Obsessive-Compulsive Behavior (D) | NS* | ns | NS | NS* |
| Paranoid Ideation (D) | NS | ns | NS | ns |
| Phobic Anxiety (D) | 0.042 | -0.024 | NS | NS |
| Psychoticism (D) | NS | ns | ns | NS |
| Somatization (D) | NS | ns | NS | NS* |
| Global Severity Index (D) | 0.025 | ns | NS | +0.005 |
| Positive Symptom Total (D) | NS* | ns | NS | +0.019 |
| Positive Symptom Distress Index (D) | NS* | ns | NS | NS |
| **Physical Examination: MCMI** | | | | |
| Basic Personality Patterns | | | | |
| Schizoid Score (C) | <0.001 | ns | NS | +<0.001 |
| Avoidant Score (C) | 0.035 | ns | NS | +0.032 |
| Dependent Score (C) | 0.033 | -0.032 | ns* | NS |
| Histrionic Score (C) | 0.014 | NS | ns | -0.003 |
| Narcissistic Score (C) | 0.025 | +0.048 | NS | ns |
| Antisocial Score (C) | NS* | NS | +0.016 | NS |
| Compulsive Score (C) | NS | NS | NS | ns |
| Passive-Aggressive Score (C) | NS* | ns | NS | NS |
| Pathological Personality Disorders | | | | |
| Schizotypal Score (C) | 0.003 | ns | NS | +0.004 |
| Borderline Score (C) | NS | -0.033 | ns | NS |
| Paranoid Score (C) | NS | NS | NS | NS |

## TABLE 9-57. (Continued)

## Summary of Categorized Current Dioxin Analyses for Psychology Variables (Ranch Hands and Comparisons)

| Variable | Unadjusted | | | |
|---|---|---|---|---|
| | All | Unknown versus Background | Low versus Background | High versus Background |
| **Physical Examination: MCMI (continued)** | | | | |
| Clinical Symptom Syndromes | | | | |
| Anxiety Score (C) | 0.038 | -0.023 | ns | NS |
| Somatoform Score (C) | NS | ns | ns | NS |
| Hypomania Score (C) | NS | NS | NS | ns* |
| Dysthymia Score (C) | NS | ns* | ns | NS |
| Alcohol Abuse Score (C) | NS | ns | ns | ns |
| Drug Abuse Score (C) | NS | ns | NS | ns |
| Psychotic Thinking Score (C) | 0.004 | ns* | ns | +0.012 |
| Psychotic Depression Score (C) | NS* | ns* | ns | NS |
| Psychotic Delusion Score (C) | NS* | NS | NS* | +0.026 |

[a]Negative difference considered adverse for this variable.
C: Continuous analysis.
D: Discrete analysis.
+: Relative risk 1.00 or greater for discrete analysis; difference in means nonnegative for continuous analysis.
-: Relative risk less than 1.00 for discrete analysis; difference in means negative for continuous analysis.
NS/ns: Not significant ($p>0.10$).
NS*/ns*: Marginally significant ($0.05<p\leq0.10$).
Note: P-value given if $p\leq0.05$.
A capital "NS" denotes relative risk 1.00 or greater for discrete analysis or difference of means nonnegative for continuous analysis; a lowercase "ns" denotes relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis; a capital "NS" in the first column does not imply directionality.

## TABLE 9-57. (Continued)

### Summary of Categorized Current Dioxin Analyses for Psychology Variables (Ranch Hands and Comparisons)

| Variable | All | Adjusted: Unknown versus Background | Adjusted: Low versus Background | Adjusted: High versus Background |
|---|---|---|---|---|
| **Questionnaire: Verified** | | | | |
| Psychoses (D) | NS | ns | ns | ns |
| Alcohol Dependence (D) | NS | NS | ns | NS |
| Anxiety (D) | NS | ns | NS | NS |
| Other Neuroses (D) | 0.024 | NS | +0.003 | NS |
| **Questionnaire: Sleep Disorders** | | | | |
| Trouble Falling Asleep (D) | NS* | ns | ns* | ns* |
| Waking Up During the Night (D) | ** (NS) | ** (ns) | ** (ns) | ** (ns) |
| Waking Up Too Early and Can't Go Back to Sleep (D) | NS | ns | ns | ns |
| Waking Up Unrefreshed (D) | NS | ns* | ns | NS |
| Involuntarily Falling Asleep During the Day (D) | NS | NS | ns | NS |
| Great or Disabling Fatigue During the Day (D) | NS | ns | NS | ns |
| Frightening Dreams (D) | 0.035 | ns | ns | +0.007 |
| Talking in Sleep (D) | NS | NS | ns | NS |
| Sleepwalking (D) | NS | NS | ns | NS |
| Abnormal Movement/ Activity During the Night (D) | NS | ns | NS | ns |
| Sleep Problems Requiring Medication (D) | NS | NS | NS | ns |
| Snore Loudly in All Sleeping Positions (D) | 0.049 | -0.050 | NS | NS |
| Insomnia (D) | NS | ns | ns | ns |
| Overall Sleep Disorder Index (D) | NS | ns | ns | NS |
| Average Sleep Each Night[a] (C) | NS | NS | NS | ns |

## TABLE 9-57. (Continued)

### Summary of Categorized Current Dioxin Analyses for Psychology Variables (Ranch Hands and Comparisons)

| Variable | All | Adjusted: Unknown versus Background | Adjusted: Low versus Background | Adjusted: High versus Background |
|---|---|---|---|---|
| **Physical Examination: SCL-90-R** | | | | |
| Anxiety (D) | NS | ns | NS | NS |
| Depression (D) | NS | ns | NS | NS* |
| Hostility (D) | NS | ns | NS | ns |
| Interpersonal Sensitivity (D) | NS | ns | ns | NS |
| Obsessive-Compulsive Behavior (D) | NS | ns | NS | NS |
| Paranoid Ideation (D) | NS | ns | NS | ns |
| Phobic Anxiety (D) | NS* | -0.033 | NS | ns |
| Psychoticism (D) | NS | ns | ns | NS |
| Somatization (D) | ** (NS) | ** (NS) | ** (NS) | ** (NS) |
| Global Severity Index (D) | NS | ns | NS | NS* |
| Positive Symptom Total (D) | NS | ns | NS | NS |
| Positive Symptom Distress Index (D) | NS* | ns | NS | NS |
| **Physical Examination: MCMI** | | | | |
| Basic Personality Patterns | | | | |
| Schizoid Score (C) | 0.027 | ns | NS | +0.006 |
| Avoidant Score (C) | NS | ns | NS | NS |
| Dependent Score (C) | NS | ns | -0.037 | NS |
| Histrionic Score (C) | NS | ns | ns | -0.020 |
| Narcissistic Score (C) | NS* | NS* | NS | ns |
| Antisocial Score (C) | ** (NS*) | ** (NS) | ** (+0.012) | ** (NS) |
| Compulsive Score (C) | NS | NS | NS | NS |
| Passive-Aggressive Score (C) | ** (NS) | ** (ns) | ** (NS) | ** (NS) |
| Pathological Personality Disorders | | | | |
| Schizotypal Score (C) | NS* | ns | ns | +0.029 |
| Borderline Score (C) | ** (NS) | ** (ns) | ** (ns) | ** (ns) |
| Paranoid Score (C) | NS | NS* | NS | NS |

## TABLE 9-57. (Continued)

### Summary of Categorized Current Dioxin Analyses for Psychology Variables (Ranch Hands and Comparisons)

| Variable | All | Adjusted: Unknown versus Background | Adjusted: Low versus Background | Adjusted: High versus Background |
|---|---|---|---|---|
| **Physical Examination: MCMI (continued)** | | | | |
| Clinical Symptom Syndromes | | | | |
| Anxiety Score (C) | ** (NS) | ** (ns) | ** (ns) | ** (NS) |
| Somatoform Score (C) | ** (NS) | ** (ns) | ** (ns) | ** (NS) |
| Hypomania Score (C) | **** | **** | **** | **** |
| Dysthymia Score (C) | ** (NS) | ** (ns) | ** (ns) | ** (NS) |
| Alcohol Abuse Score (C) | **** | **** | **** | **** |
| Drug Abuse Score (C) | NS | ns | NS | ns |
| Psychotic Thinking Score (C) | NS | ns | ns | NS |
| Psychotic Depression Score (C) | NS | ns | ns | NS |
| Psychotic Delusion Score (C) | NS | NS | NS | NS |

[a]Negative difference considered adverse for this variable.
C: Continuous analysis.
D: Discrete analysis.
+: Relative risk 1.00 or greater for discrete analysis; difference in means nonnegative for continuous analysis.
-: Relative risk less than 1.00 for discrete analysis; difference in means negative for continuous analysis.
NS/ns: Not significant ($p>0.10$).
NS*/ns*: Marginally significant ($0.05<p\leq0.10$).
** (NS)/** (ns): Categorized current dioxin-by-covariate interaction ($0.01<p\leq0.05$); not significant when interaction is deleted; refer to Appendix Table H-1 for a detailed description of this interaction.
** (NS*): Categorized current dioxin-by-covariate interaction ($0.01<p\leq0.05$), marginally significant when interaction is deleted; refer to Appendix Table H-1 for a detailed description of this interaction.
** (...): Categorized current dioxin-by-covariate interaction ($0.01<p\leq0.05$); significant when interaction is deleted and p-value is given in parentheses; refer to Appendix Table H-1 for a detailed description of this interaction.
****: $Log_2$ (current dioxin)-by-time-by-covariate interaction ($p\leq0.01$); refer to Appendix Table H-1 for a detailed description of this interaction.
Note: P-value given if $p\leq0.05$.
A capital "NS" denotes relative risk 1.00 or greater for discrete analysis or difference of means nonnegative for continuous analysis; a lowercase "ns" denotes relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis; a capital "NS" in the first column does not imply directionality.

The adjusted analyses of the verified psychological disorder variables did not detect any significant interactions between current dioxin and time since tour or any significant associations with current dioxin within the time strata. There was a marginally significant positive association exhibited between other neuroses and current dioxin for Ranch Hands in the maximal cohort with 18.6 years or less since the end of their tour.

***Model 3: Ranch Hand and Comparisons by Current Dioxin Category***

In the unadjusted analyses of the verified psychological variables, other neuroses was the only variable with a significant overall contrast of the four current dioxin categories (Table 9-57: p=0.008). For this variable, the percentage of verified cases was significantly higher for the Ranch Hands in the low current dioxin category than for the Comparisons in the background category (p=0.003).

The adjusted analyses showed results similar to those of the unadjusted analyses. Other neuroses was the only verified psychological variable to have a significant overall contrast (Table 9-57: p=0.024), and the contrast of the low versus background category was again significant (p=0.003) with the percentage of verified cases higher for the low category.

**Questionnaire: Sleep Disorders**

Based on participants' responses to a series of questions regarding sleep problems, 12 disorders were analyzed. In addition, insomnia (defined using 3 of the 12 disorders), are overall sleep disorder index, and average sleep each night were analyzed. Ranch Hands and Comparisons with PTSD based on the 1985 MMPI were excluded from the analyses of the sleep disorder variables.

***Model 1: Ranch Hands - $Log_2$ (Initial Dioxin)***

Unadjusted analyses found that none of the sleep disorders was significantly associated with initial dioxin under the minimal assumption. However, under the maximal assumption, the sleep disorders of waking up unrefreshed and frightening dreams were significantly related to an increase in initial dioxin (Table 9-55: p=0.027 and p=0.025, respectively).

Under both assumptions, the adjusted analysis found significant negative relationships between initial dioxin and the disorder of sleep problems that required medication (Table 9-55: p=0.023 for the minimal assumption and p=0.032 for the maximal assumption). Also, under the maximal assumption, there was a marginally significant positive association between initial dioxin and the percentage of Ranch Hands who reported having trouble falling asleep. Similarly, under the maximal assumption, there was a marginally significant positive association between initial dioxin and the frequency of Ranch Hands who experienced frightening dreams.

Table 9-58 lists several significant initial dioxin-by-covariate interactions in the adjusted analyses. Stratified results showed older Ranch Hands and Ranch Hands with a college education generally had a positive association between initial dioxin and the sleep disorders while younger Ranch Hands and Ranch Hands with a high school education had a

## TABLE 9-58.

### Summary of Dioxin-by-Covariate Interactions from Adjusted Analyses of Psychology Variables

| Variable | Assumption | Covariate |
|---|---|---|
| **Model 1: Ranch Hands - $Log_2$ (Initial Dioxin)** | | |
| Waking Up Too Early and Can't Go Back to Sleep | Minimal | AGE |
| Involuntarily Falling Asleep During the Day | Minimal | RACE |
| Involuntarily Falling Asleep During the Day | Maximal | RACE |
| Frightening Dreams | Minimal | EDUC |
| Sleepwalking | Minimal | EDUC |
| Snore Loudly in All Sleeping Positions | Minimal | AGE |
| Interpersonal Sensitivity (SCL-90-R) | Minimal | EDUC |
| Avoidant Score (MCMI) | Minimal | EDUC |
| Antisocial Score (MCMI) | Minimal | ALC |
| Antisocial Score (MCMI) | Maximal | ALC |
| Borderline Score (MCMI) | Maximal | EDUC |
| Anxiety Score (MCMI) | Minimal | RACE |
| Anxiety Score (MCMI) | Maximal | RACE |
| Hypomania Score (MCMI) | Minimal | RACE |
| Hypomania Score (MCMI) | Maximal | RACE |
| Dysthymia Score (MCMI) | Minimal | RACE |
| Dysthymia Score (MCMI) | Maximal | RACE |
| **Model 2: Ranch Hands - $Log_2$ (Current Dioxin) and Time** | | |
| Waking Up During the Night | Minimal | AGE |
| Waking Up During the Night | Maximal | ALC |
| Waking Up Unrefreshed | Minimal | AGE |
| Great or Disabling Fatigue During the Day | Minimal | AGE |
| Frightening Dreams | Minimal | RACE |
| Frightening Dreams | Maximal | RACE |
| Average Sleep Each Night | Minimal | RACE |
| Average Sleep Each Night | Maximal | RACE |
| Phobic Anxiety (SCL-90-R) | Minimal | RACE |
| Phobic Anxiety (SCL-90-R) | Maximal | RACE |
| Somatization (SCL-90-R) | Maximal | ALC |
| Global Severity Index (SCL-90-R) | Minimal | RACE |
| Schizoid Score (MCMI) | Maximal | DRKYR |

**TABLE 9-58. (Continued)**

**Summary of Dioxin-by-Covariate Interactions from Adjusted Analyses of Psychology Variables**

| Variable | Assumption | Covariate |
|---|---|---|
| **Model 3: Ranch Hands and Comparisons by Current Dioxin Category** | | |
| Histrionic Score (MCMI) | - - | RACE |
| Waking Up During the Night | - - | RACE |
| Somatization (SCL-90-R) | - - | RACE |
| Antisocial Score (MCMI) | - - | ALC |
| Passive-Aggressive Score (MCMI) | - - | AGE |
| Borderline Score (MCMI) | - - | EDUC |
| Anxiety Score (MCMI) | - - | RACE |
| Somatoform Score (MCMI) | - - | ALC, DRKYR |
| Hypomania Score (MCMI) | - - | RACE |
| Dysthymia Score (MCMI) | - - | RACE |
| Alcohol Abuse Score (MCMI) | - - | RACE |

corresponding negative association. After deletion of these interactions from the adjusted models, none of the variables exhibited a significant association with initial dioxin.

***Model 2: Ranch Hands - $Log_2$ (Current Dioxin) and Time***

The unadjusted current dioxin and time since tour analyses of the sleep disorder variables did not exhibit any significant results under the minimal assumption. The maximal unadjusted analyses detected a marginally significant current dioxin-by-time interaction for the variables involuntarily falling asleep during the day and insomnia. However, the associations within the time strata were nonsignificant for both of these variables.

Also under the maximal assumption, the unadjusted analysis displayed a significant positive association between current dioxin and waking up unrefreshed for the time greater than 18.6 years stratum and between current dioxin and frightening dreams for the less than or equal to 18.6 years time stratum (Table 9-56: p=0.030 and p=0.011, respectively).

The adjusted analysis of the minimal cohort was similar to the corresponding unadjusted analysis. There were no significant current dioxin-by-time since tour interactions for the minimal cohort, but there were marginally significant negative associations between current dioxin and sleep problems requiring medication for both time strata and between current dioxin and the overall sleep disorder index for Ranch Hands with early tours. Under the maximal assumption, the current dioxin-by-time since tour interaction was marginally significant for both involuntarily falling asleep during the day and insomnia. Also, after the deletion of a current dioxin-by-time-by-race interaction, the maximal analysis detected a significant positive association between current dioxin and frightening dreams for the less than or equal to 18.6 years time stratum (Table 9-56: p=0.033). For Ranch Hands with early tours, there were marginally significant negative associations with current dioxin for sleep problems requiring medication and insomnia.

For several of the sleep disorder variables, there was a significant interaction among current dioxin, time since tour, and one of the covariates (listed in Table 9-58). Four of these interactions were with the race covariate and were mainly caused by the sparse number of Blacks with sleep disorders in the analyses.

***Model 3: Ranch Hands and Comparisons by Current Dioxin Category***

The unadjusted and adjusted analyses of the sleep disorder variables and categorized current dioxin were generally not significant. In the unadjusted analysis of trouble falling asleep, the contrast of the low versus background current dioxin category was marginally significant with the prevalence of trouble falling asleep lower for the Ranch Hands in the low category than for the Comparisons in the background category. The unadjusted analysis of waking up unrefreshed found a marginally significant overall difference among the current dioxin categories, with the percentage of cases of the sleep disorder lower for the Ranch Hands in the unknown category than for the Comparisons in the background category.

In the unadjusted analysis of the sleep disorder variables and categorized current dioxin, frightening dreams was the only variable with a significant overall contrast of the four

current dioxin categories (Table 9-57: p=0.010). The percentage of Ranch Hands in the high category who reported frightening dreams was significantly higher than the corresponding percentage of Comparisons in the background category (p=0.002). Similarly, the unadjusted analysis of talking in sleep displayed a significantly higher prevalence of the sleep disorder for Ranch Hands in the high current dioxin category than for Comparisons in the background category (p=0.038).

The adjusted analysis of trouble falling asleep detected a marginally significant overall contrast of the four current dioxin categories. The contrasts of low versus background and high versus background were also marginally significant with the prevalence of trouble falling asleep higher for Comparisons in the background category than for Ranch Hands in the low and high categories. The unknown versus background contrast for waking up unrefreshed was also marginally significant with the unknown category having a lower percentage of participants with the sleep disorder.

In the adjusted analysis, the only sleep disorders with a significant overall contrast of the four current dioxin categories were frightening dreams and snore loudly in all sleeping positions (Table 9-57: p=0.035 and p=0.049, respectively). The analysis of frightening dreams found the percentage of Ranch Hands in the high category who reported frightening dreams was significantly higher than the percentage of Comparisons in the background category (p=0.007). In contrast, the percentage of Ranch Hands in the unknown category who snored loudly in all sleeping positions was significantly lower than the corresponding percentage of Comparisons in the background category (p=0.050).

Only one significant categorized current dioxin-by-covariate interaction was detected (listed in Table 9-58). The analysis was of waking up during the night, and the covariate was race. This interaction was also most likely caused by the sparse number of Blacks who reported waking up during the night.

## Physical Examination: SCL-90-R Variables

The SCL-90-R, a multidimensional self-reported symptom inventory designed to measure symptomatic psychological distress, presented nine primary symptom measures and three global indices of distress for evaluation. Participants with PTSD based on the 1985 MMPI were excluded from the analysis of these variables.

### *Model 1: Ranch Hands - $Log_2$ (Initial Dioxin)*

In the unadjusted analysis of the minimal cohort, there was a marginally significant positive association between initial dioxin and the following SCL-90-R variables: depression, obsessive-compulsive behavior, global severity index, and positive symptom total. Under the maximal assumption, the positive association with initial dioxin became significant for each of the aforementioned variables. The maximal unadjusted analysis also detected significant positive associations with initial dioxin for anxiety and psychoticism and marginally significant positive associations for interpersonal sensitivity and somatization.

After adjusting for covariate information, the minimal analysis of the SCL-90-R variables did not detect a significant association with initial dioxin for any of the variables. The maximal adjusted analysis did detect a marginally significant positive association between initial dioxin and obsessive-compulsive behavior and psychoticism.

The adjusted analysis of the SCL-90-R variables and initial dioxin only detected one significant initial dioxin-by-covariate interaction. Under the minimal assumption, the analysis of interpersonal sensitivity displayed a significant interaction between initial dioxin and education (listed in Table 9-58), but stratified results did not show a significant initial dioxin effect for Ranch Hands with either a high school or college education level. After deletion of this interaction from the model, the analysis of interpersonal sensitivity remained nonsignificant.

***Model 2: Ranch Hands - $Log_2$ (Current Dioxin) and Time***

The association between current dioxin and the SCL-90-R variables did not differ significantly between time since tour strata for any of the unadjusted analyses except the minimal analysis of somatization (Table 9-56: p=0.015). The minimal unadjusted analysis of this variable also detected a marginally significant positive association with current dioxin for Ranch Hands with more than 18.6 years since tour.

For anxiety and depression, the unadjusted analysis under the minimal assumption detected significant positive associations with current dioxin for Ranch Hands with greater than 18.6 years since tour (Table 9-56: p=0.031 and p=0.017, respectively). Similar marginally significant associations existed for the corresponding analyses under the maximal assumption. The unadjusted analysis of interpersonal sensitivity displayed a marginally significant positive association with current dioxin for Ranch Hands with less than or equal to 18.6 years since tour under the minimal assumption. A significant positive association existed for the same analysis under the maximal assumption (p=0.018).

For the SCL-90-R obsessive-compulsive behavior symptom, the minimal unadjusted analysis detected a significant positive association with current dioxin for Ranch Hands with more than 18.6 years since tour (Table 9-56: p=0.031). The maximal analysis of this same variable displayed a significant positive associations with current dioxin for both time strata ($\leq$18.6: p=0.043; >18.6: p=0.018). The unadjusted analysis of the global severity index also found a significant positive association with current dioxin for Ranch Hands in the greater than 18.6 years time stratum of the minimal cohort (p=0.026). The maximal analysis of the global severity index detected a positive association with current dioxin of borderline significance for both time strata. Under the maximal assumption, the unadjusted analysis of the positive symptom total exhibited a significant positive association with current dioxin for Ranch Hands with 18.6 years or less since tour (p=0.041).

The adjusted minimal analyses found a marginally significant current dioxin-by-time since tour interaction for anxiety and significant current dioxin-by-time interaction for somatization (Table 9-56: p=0.025). In contrast, the same analyses restricted to Ranch Hands with more than 18.6 years since tour found a significant positive association between anxiety and current dioxin (p=0.028) and marginally significant positive association between

current dioxin and somatization. Under the maximal assumption, the interaction between current dioxin and time was not significant for any SCL-90-R variables. However, for Ranch Hands with less than or equal to 18.6 years since tour, there was a marginally significant positive association between current dioxin and interpersonal sensitivity.

Table 9-58 lists four current dioxin-by-time-by-covariate interactions for the SCL-90-R analyses. Three of these interactions were with the covariate race and were consequently caused by the sparse number of Blacks with abnormal scores. After deletion of these interactions from the models, the analyses were all nonsignificant.

***Model 3: Ranch Hands and Comparisons by Current Dioxin Category***

The unadjusted analyses of categorized current dioxin found significant overall differences among the four current dioxin categories for anxiety, phobic anxiety, and the global severity index (Table 9-57: p=0.043, p=0.042, and p=0.025) and marginally significant overall differences significant overall differences for depression, obsessive-compulsive behavior, the positive symptom total, and the positive symptom distress index. Specifically, Ranch Hands in the high current dioxin category had a significantly higher prevalence of anxiety and depression (p=0.012 and p=0.015, respectively), and a significantly greater percentage of participants classified as abnormal on the global severity index and positive symptom total (p=0.005 and p=0.019) than the Comparisons in the background category. These Ranch Hands also had a marginally higher risk of obsessive-compulsive behavior and somatization. In contrast, Ranch Hands in the unknown current dioxin category had a significantly lower prevalence of phobic anxiety than the Comparisons in the background category (p=0.042). The Ranch Hands in the low current dioxin category did not differ from the Comparisons for any of the 12 SCL-90-R variables.

The Ranch Hands in the unknown current dioxin category had a lower risk of all the SCL-90-R symptoms than the Comparisons in the background category. However, the Ranch Hands in the low category had a higher risk for all but two of the SCL-90-R variables (interpersonal sensitivity and psychoticism) and those in the high current dioxin category had a higher risk for all of the SCL-90-R symptoms (except paranoid ideation) than the Comparisons in the background category.

In the adjusted analyses of categorized current dioxin, the overall contrasts of the four current dioxin categories were marginally significant for phobic anxiety and the positive symptom distress index. Also, in the adjusted analysis of depression and the global severity index, the contrast of the background versus high category was marginally significant with the Ranch Hands in the high category having a higher risk than the Comparisons in the background category. Similar to the unadjusted analysis, the Ranch Hands in the unknown current dioxin category had a significantly lower prevalence of phobic anxiety than the Comparisons in the background category (Table 9-57: p=0.033).

The adjusted analyses of categorized current dioxin with the SCL-90-R variables only detected one significant interaction between categorized current dioxin and a covariate (listed in Table 9-58). The interaction was with race in the analysis of somatization and was caused

by the sparse number of Blacks with abnormal somatization scores in the analysis. After deletion of this interaction, the analysis was nonsignificant.

**Physical Examination: MCMI Variables**

The MCMI, a self-administered test, presented scores for eight basic personality patterns, three pathological personality disorders, and nine clinical symptom syndromes to be evaluated. Participants with PTSD based on the 1985 MMPI were excluded from the analyses.

***Model 1: Ranch Hands - $Log_2$ (Initial Dioxin)***

Unadjusted analyses found that initial dioxin was positively associated with the MCMI schizoid, avoidant, dependent, passive-aggressive, schizotypal, anxiety, psychotic thinking, and psychotic depression scores under both the minimal and the maximal assumptions (Table 9-55: $p<0.03$ for all analyses). For the histrionic and narcissistic scores, there were a significant negative associations with initial dioxin under both assumptions ($p<0.01$ for all analyses). The unadjusted analyses of the borderline, somatoform, and dysthymia scores detected significant positive associations with initial dioxin for the maximal cohort ($p<0.04$ for all analyses). For the hypomania score, there was a negative association with initial dioxin of borderline significance under the minimal assumption. The unadjusted analysis of the psychotic delusion score found a marginally significant positive association with initial dioxin under the maximal assumption. For the remaining five MCMI variables (antisocial, compulsive, paranoid, alcohol abuse, and drug abuse scores), the unadjusted results were nonsignificant under both assumptions.

The adjusted analyses of the MCMI variables were similar to the unadjusted analyses. Significant positive associations with initial dioxin were displayed for the schizoid, avoidant (after deletion of an initial dioxin-by-education interaction), dependent, schizotypal, and psychotic thinking scores under both assumptions (Table 9-55: $p<0.04$ for all analyses). The adjusted analysis of the MCMI histrionic score detected a significant negative association with initial dioxin for both the maximal and the minimal cohorts ($p<0.04$ for both analyses). The minimal analysis of the narcissistic score detected a marginally significant negative association with initial dioxin while the maximal analysis displayed a similar significant association.

After the deletion of an initial dioxin-by-race interaction, the minimal analysis detected a marginally significant positive relationship between initial dioxin and the anxiety score and a marginally significant negative association between initial dioxin and the hypomania score. Under the maximal assumption, there was a significant positive association between initial dioxin and the somatoform score (Table 9-55: $p=0.011$). The minimal analysis of the psychotic depression score exhibited a significant positive association with initial dioxin ($p=0.035$), and there was a similar marginally significant association under the maximal assumption.

Table 9-58 lists several initial dioxin-by-covariate interactions for the MCMI variables. Stratified analyses of the interactions between initial dioxin and education indicated a

stronger positive relationship for Ranch Hands with a college education than for those with a high school education. Also, the interactions involving current alcohol use showed a stronger negative association with initial dioxin for Ranch Hands with increased current alcohol levels. In the stratified analyses of the initial dioxin-by-race interactions for the anxiety and dysthymia scores, Blacks had a negative association with initial dioxin while non-Blacks displayed a positive association. In contrast, the stratified analysis of the initial dioxin-by-race interaction for the hypomania score exhibited a positive association with initial dioxin for Blacks and a negative association for non-Blacks. However, the results of the stratified analyses of the initial dioxin-by-race interactions may have been distorted by the small number of Blacks in the analyses.

***Model 2: Ranch Hands - $Log_2$ (Current Dioxin) and Time***

In the unadjusted analysis of the MCMI variables, the avoidant score was the only variable with a significant current dioxin-by-time since tour interaction under the minimal assumption (Table 9-56: $p=0.028$). Marginally significant interactions between current dioxin and time were exhibited for the schizoid, histrionic, and psychotic thinking scores. There were no significant results for the time less than or equal to 18.6 years stratum for the MCMI variables under the minimal assumption. However, for Ranch Hands with greater than 18.6 years since tour, there were significant positive associations with current dioxin for the schizoid, avoidant, dependent, passive-aggressive, schizotypal, anxiety, psychotic thinking, psychotic depression, and psychotic delusion scores ($p<0.05$ for each analysis). Also, the analyses of the histrionic and narcissistic scores detected significant negative associations with current dioxin for this same time stratum under the minimal assumption, and a similar marginally significant negative relationship for the hypomania score.

Under the maximal assumption, the unadjusted analyses did not detect any significant current dioxin-by-time since tour interactions for the MCMI variables. However, the interaction between current dioxin and time since tour was marginally significant for the schizoid, avoidant, histrionic, and psychotic thinking scores. The maximal unadjusted analyses of the passive-aggressive, schizotypal, and anxiety scores detected significant positive associations with current dioxin for both time strata. (Table 9-56: $p<0.05$ for all analyses).

Similar to the minimal unadjusted analyses, the maximal analyses of the schizoid, avoidant, dependent, psychotic thinking, psychotic depression, and psychotic delusion scores exhibited significant positive associations with current dioxin for Ranch Hands with greater than 18.6 years since tour. Also, the same analyses of the histrionic, narcissistic, and hypomania scores displayed significant negative associations with current dioxin. For Ranch Hands in the time less than or equal to 18.6 years stratum, the maximal unadjusted analysis detected a marginally significant positive association between the somatoform score and current dioxin. The analysis of the borderline and dysthymia scores displayed a marginally significant positive association with current dioxin for the greater than 18.6 years stratum.

Similar to the minimal unadjusted analyses, the minimal adjusted analyses of the MCMI variables detected a significant current dioxin-by-time since tour interaction for only the avoidant score under the minimal assumption (Table 9-56: $p=0.029$). There were also marginally significant current dioxin-by-time interactions for the schizoid and psychotic

thinking scores. As in the unadjusted analyses, there were no significant results for the time less than or equal to 18.6 years stratum under the minimal assumption.

For Ranch Hands in the greater than 18.6 years since tour time stratum of the minimal cohort, there were significant positive associations with current dioxin for the schizoid, avoidant, dependent, schizotypal, psychotic thinking, and psychotic depression scores (Table 9-56: $p<0.035$ for each analysis). For this same time stratum, there was a significant negative association between current dioxin and the histrionic score ($p=0.006$) and a similar marginally significant negative relationship between current dioxin and the narcissistic and hypomania scores. Also, there was a marginally significant positive association between current dioxin and the anxiety score.

Under the maximal assumption, the current dioxin-by-time since tour interaction was significant only for the schizoid score (after deletion of a current dioxin-by-time-by-lifetime alcohol history interaction) and the avoidant score (Table 9-56: $p=0.044$ and $p=0.045$). There were also marginally significant current dioxin-by-time interactions for the narcissistic and psychotic thinking scores.

The adjusted maximal analysis detected a significant positive association between current dioxin and the somatoform score for Ranch Hands with less than or equal to 18.6 years since tour (Table 9-56: $p=0.030$). This was the only significant result found for the maximal adjusted analyses of this time stratum.

For the greater than 18.6 years time stratum, several of the maximal adjusted analyses were significant. A significant positive association was detected with current dioxin for the following MCMI variables: schizoid score (after deletion of the current dioxin-by-time-by-lifetime alcohol history interaction), avoidant score, dependent score, schizotypal score, psychotic thinking score, and psychotic depression score (Table 9-56: $p<0.30$ for each analysis). There were also significant negative associations with current dioxin for the narcissistic and hypomania scores. The positive associations between current dioxin and the dysthymia score and between current dioxin and the psychotic delusion score were marginally significant.

Only two current dioxin-by-time-by-covariate interactions were detected in the maximal adjusted analysis (Table 9-58).

***Model 3: Ranch Hands and Comparisons by Current Dioxin Category***

In the unadjusted analysis of the four current dioxin categories, 8 out of 20 of the MCMI variables displayed a significant overall contrast of the four categories: schizoid, avoidant, dependent, histrionic, narcissistic, schizotypal, anxiety, and psychotic thinking scores (Table 9-57: $p<0.04$ for all analyses). The unadjusted analyses also exhibited marginally significant overall simultaneous contrasts of the four current dioxin categories for the antisocial, passive-aggressive, psychotic depression, and psychotic delusion scores.

The unadjusted analyses found that Ranch Hands in the unknown current dioxin category had significantly lower mean dependent, borderline, and anxiety scores than the

Comparisons in the background category (Table 9-57: $p<0.04$ for all analyses). These Ranch Hands also had marginally lower average dysthymia, psychotic thinking, and psychotic depression scores than the Comparisons. In contrast, the unadjusted analyses showed the Ranch Hands in the unknown category had a significantly higher mean narcissistic score than the Comparisons in the background category ($p=0.048$).

Very few differences were found between the mean MCMI scores of the Ranch Hands in the low current dioxin category and the Comparisons in the background category in the unadjusted analyses. These Ranch Hands did have a significantly higher mean antisocial score than the Comparisons (Table 9-57: $p=0.016$) and a marginally higher mean psychotic delusion score. The contrast of the mean dependent score of the Ranch Hands in the low category versus the mean score of the Comparisons in the background category was of borderline significance with the Ranch Hands having a lower mean dependent score than the Comparisons.

The unadjusted analyses detected significantly higher mean schizoid, avoidant, schizotypal, psychotic thinking, and psychotic delusion scores for the Ranch Hands in the high current dioxin category than the Comparisons in the background category (Table 9-57: $p<0.04$ for all analyses). These Ranch Hands also had a significantly lower mean histrionic score ($p=0.003$) and a marginally lower hypomania score than the Comparisons in the background category.

Only 7 of the 20 MCMI variables had significant or marginally significant results after adjusting for covariate information. The overall contrast of the four current dioxin categories was significant for only the schizoid score (Table 9-57: $p=0.027$). Marginally significant overall differences among the four current dioxin categories were also found for the narcissistic, antisocial (after deletion of a categorized current dioxin-by-current alcohol use interaction), and schizotypal scores.

In the adjusted analysis, the contrast of the Ranch Hands in the unknown category and the Comparisons in the background category was of borderline significance for the narcissistic score and the paranoid score with Ranch Hands having higher mean scores than the Comparisons. The adjusted analyses also found Ranch Hands in the low current dioxin category had a significantly lower mean dependent score than Comparisons in the background category (Table 9-57: $p=0.037$). In addition, after the deletion of a categorized current dioxin-by-current alcohol use interaction, the adjusted analysis found that the Ranch Hands in the low category had a significantly higher mean antisocial score than the Comparisons ($p=0.012$). The adjusted analyses also showed that Ranch Hands in the high current dioxin category had significantly higher mean schizoid and schizotypal scores ($p=0.006$ and $p=0.029$) and a significantly lower histrionic score ($p=0.020$) than the Comparisons in the background category.

The adjusted analyses of the MCMI variables detected several categorized current dioxin-by-covariate interactions (listed in Table 9-58). After deletion of these interactions, the adjusted analyses were nonsignificant except as stated above for the antisocial score. The stratified analyses of these interactions did not detect any overlying dioxin effects or patterns for the individual strata.

## CONCLUSION

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 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.

# CHAPTER 9

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